John Crigler

Durable Anchors

- Swiss Practice
- Grouting

Temporary

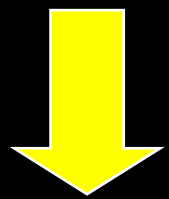
- Duration of use in principle < 2 years
  - Standard: load cannot be adjusted (unless with special measures)
- Extractable: strands of the free length can be extracted

Permanent

- Anchors with a life expectancy of > 2 years as well as temporary anchors installed in a corrosive environment or subject to a critical level of stray currents
  - Standard: Load usually cannot be changed after load transfer
  - Controllable: Load can be checked periodically
  - Adjustable: Load can be adjusted or released
  - Surveillance Anchors: Load can be permanently checked with a load cell

Electrically Isolated Anchors

- Vital unseen anchor components cannot be inspected or replaced
- Trend towards more stringent corrosion protection requirements
- Examples of anchor failure due to tendon corrosion



Electrically Isolated Anchors

Anchor is fully encapsulated against stray currents, chlorides, other aggressive elements ….

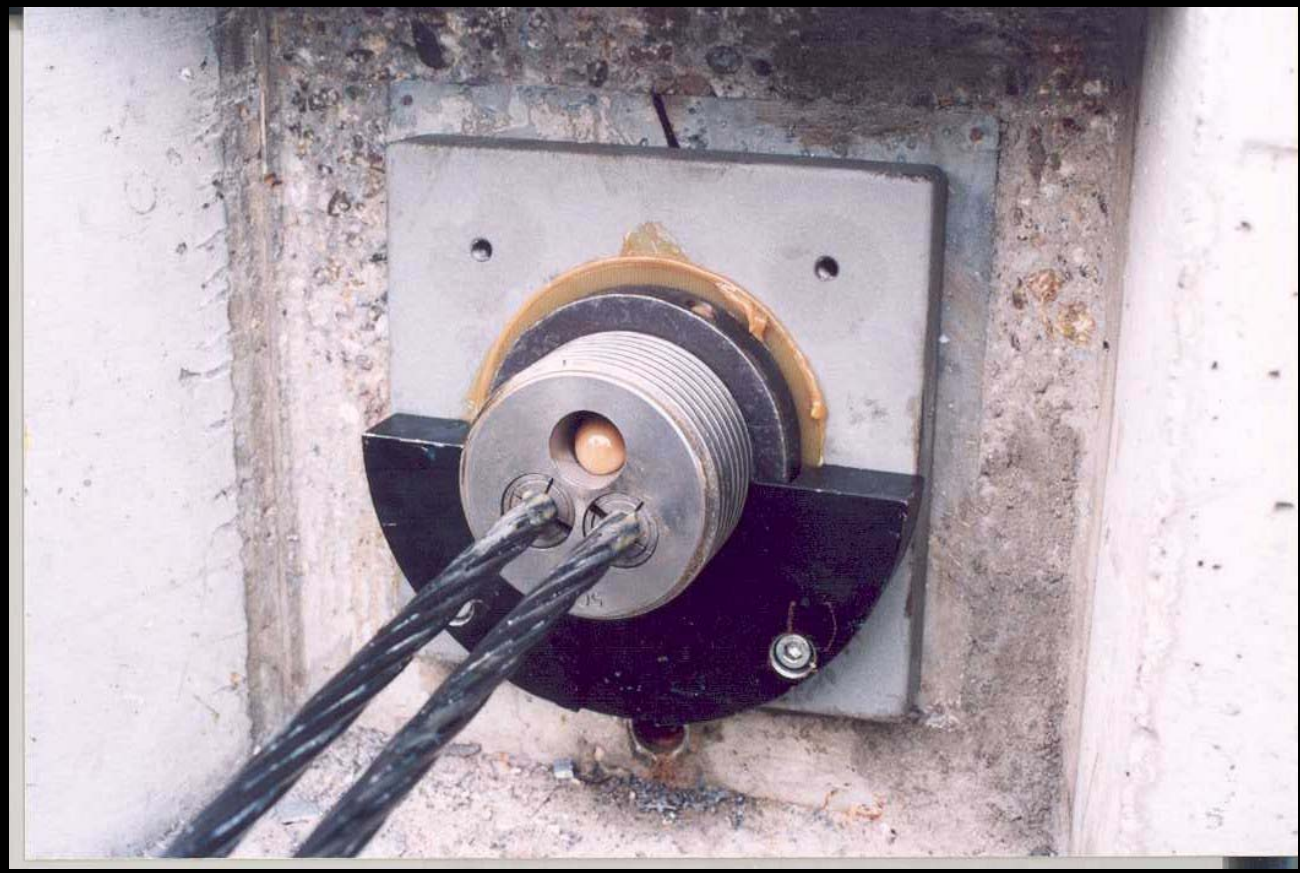
- Integrity of anchor encapsulation can be monitored at any stage in the anchor ’s life

Electrically Isolated Anchors

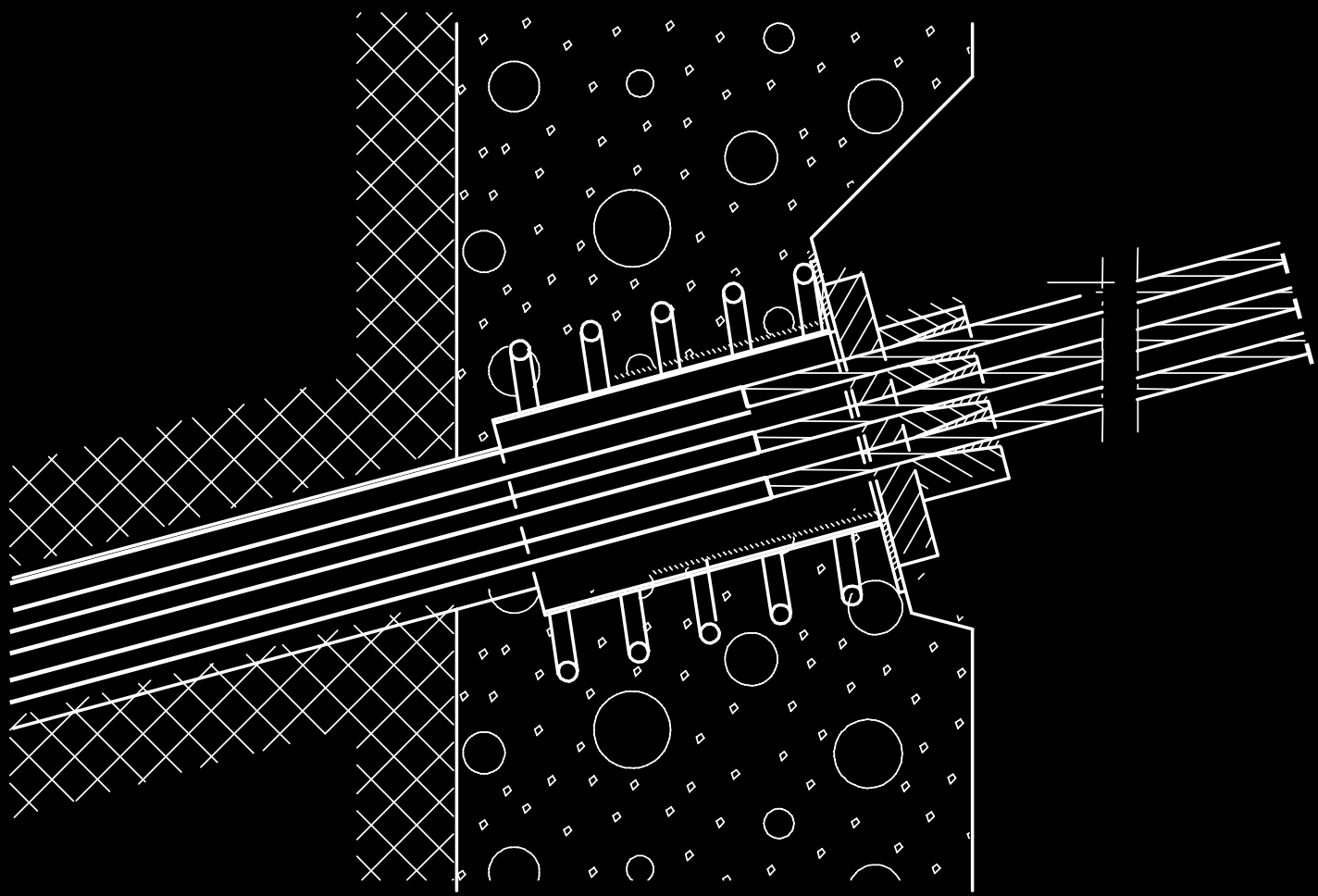
- First project - Stadelhofen railway station in Zürich (1986)
- 945 permanent anchors specified with working life > 100 years
- Since 1995: Electrically isolated anchors have been the standard in Switzerland for all permanent anchors

Electrically Isolated Anchors

Electrically Isolated Anchors

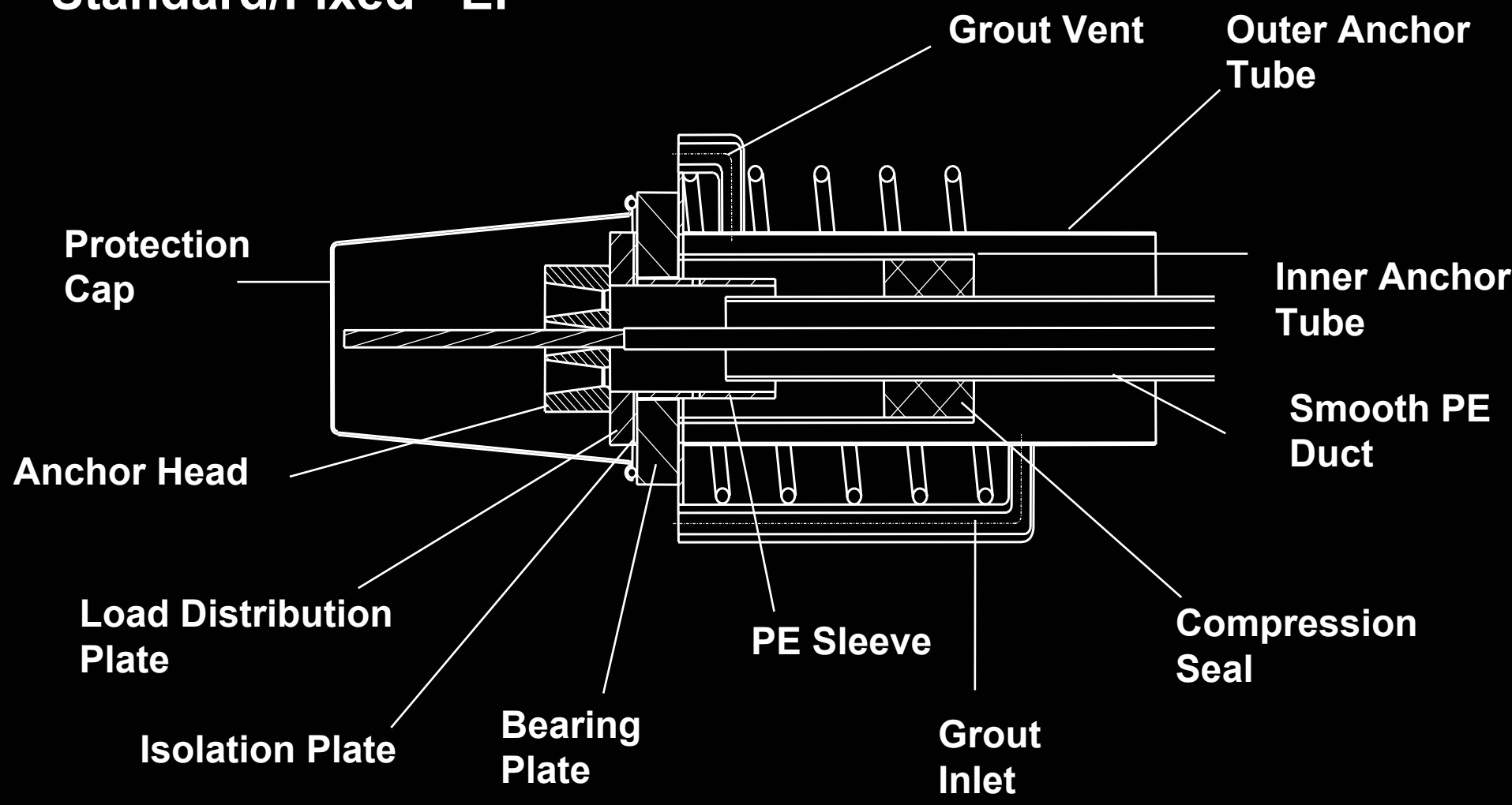


Temporary Anchorage – E



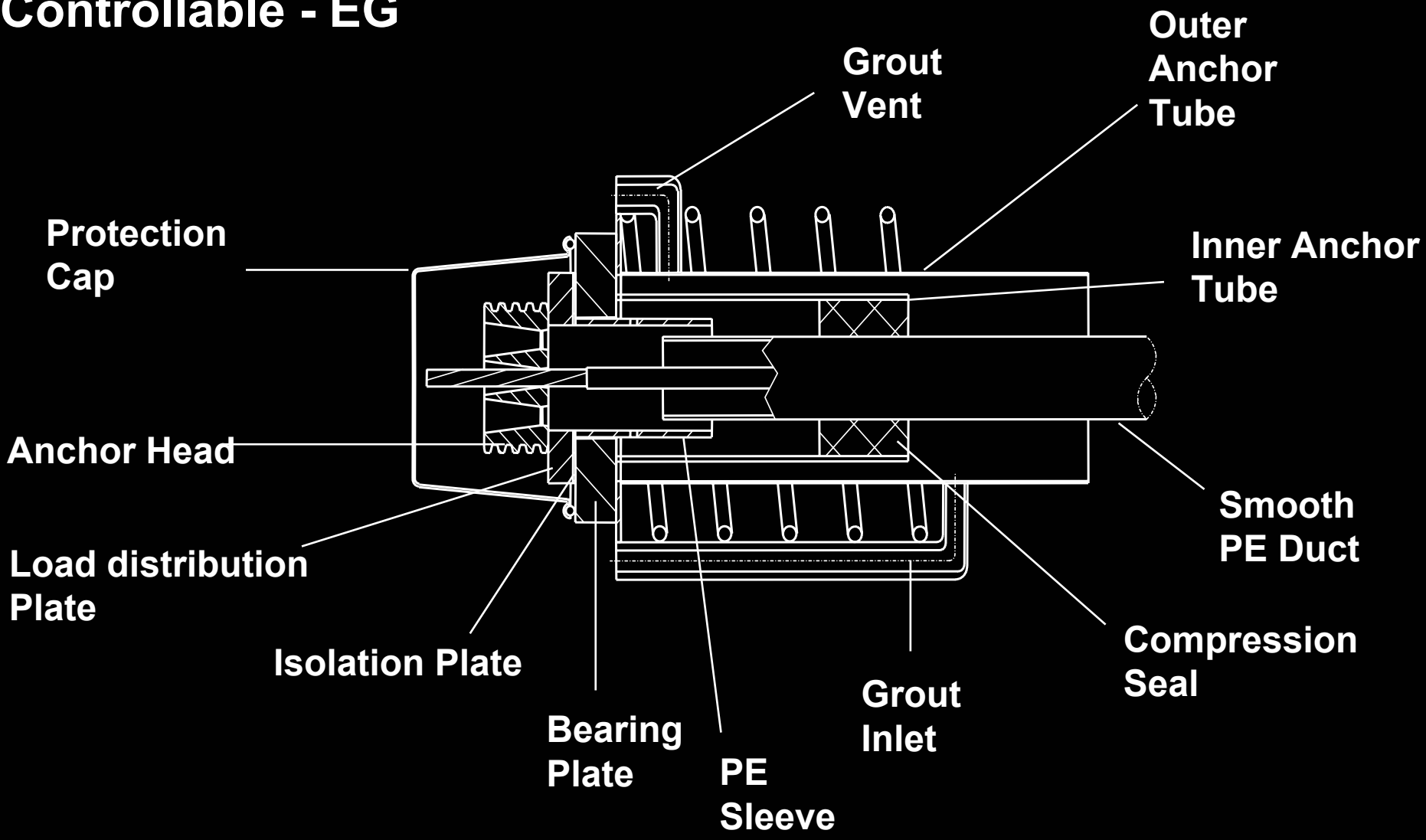
Permanent Anchorage

Standard/Fixed - EF



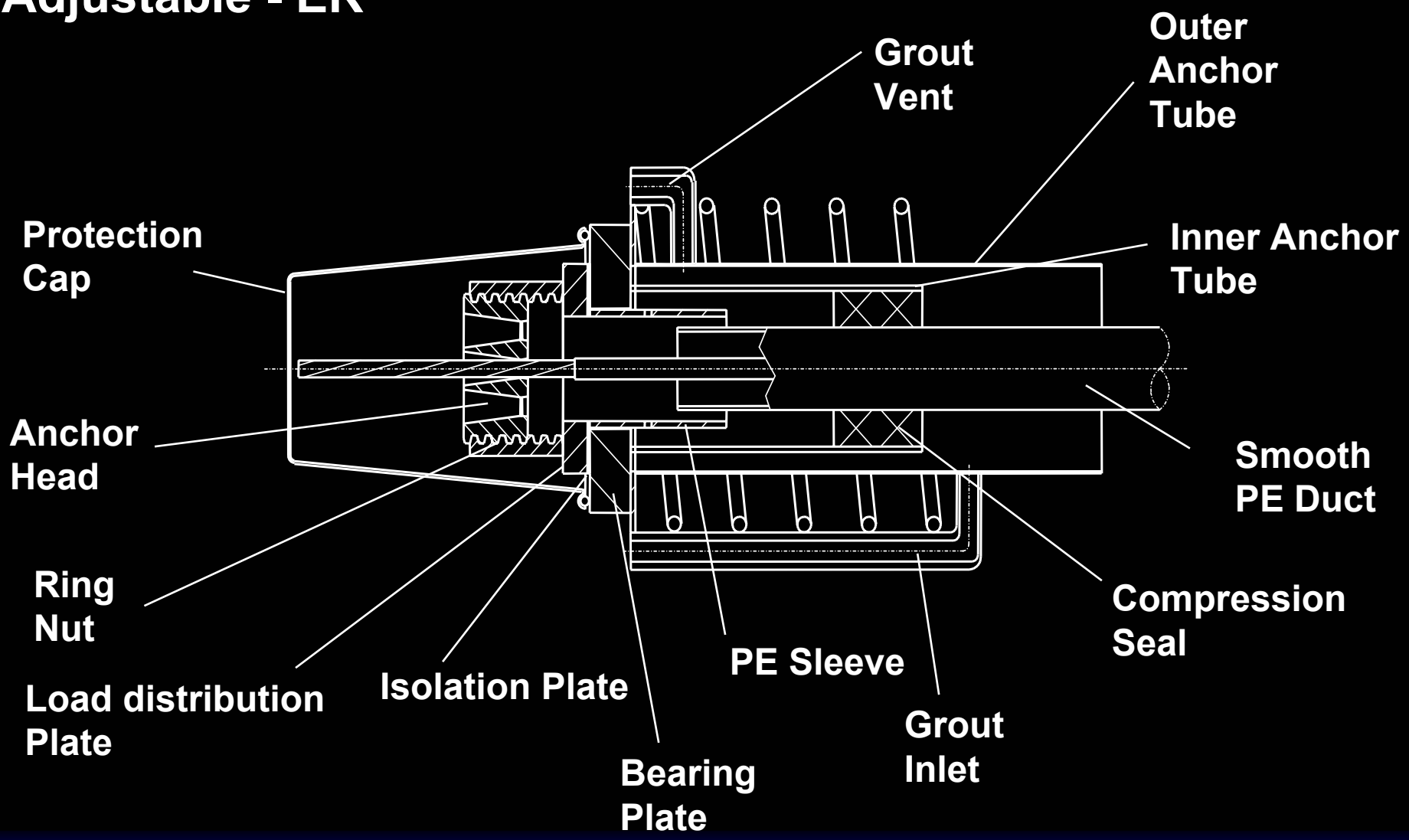
Permanent Anchorage

Controllable - EG



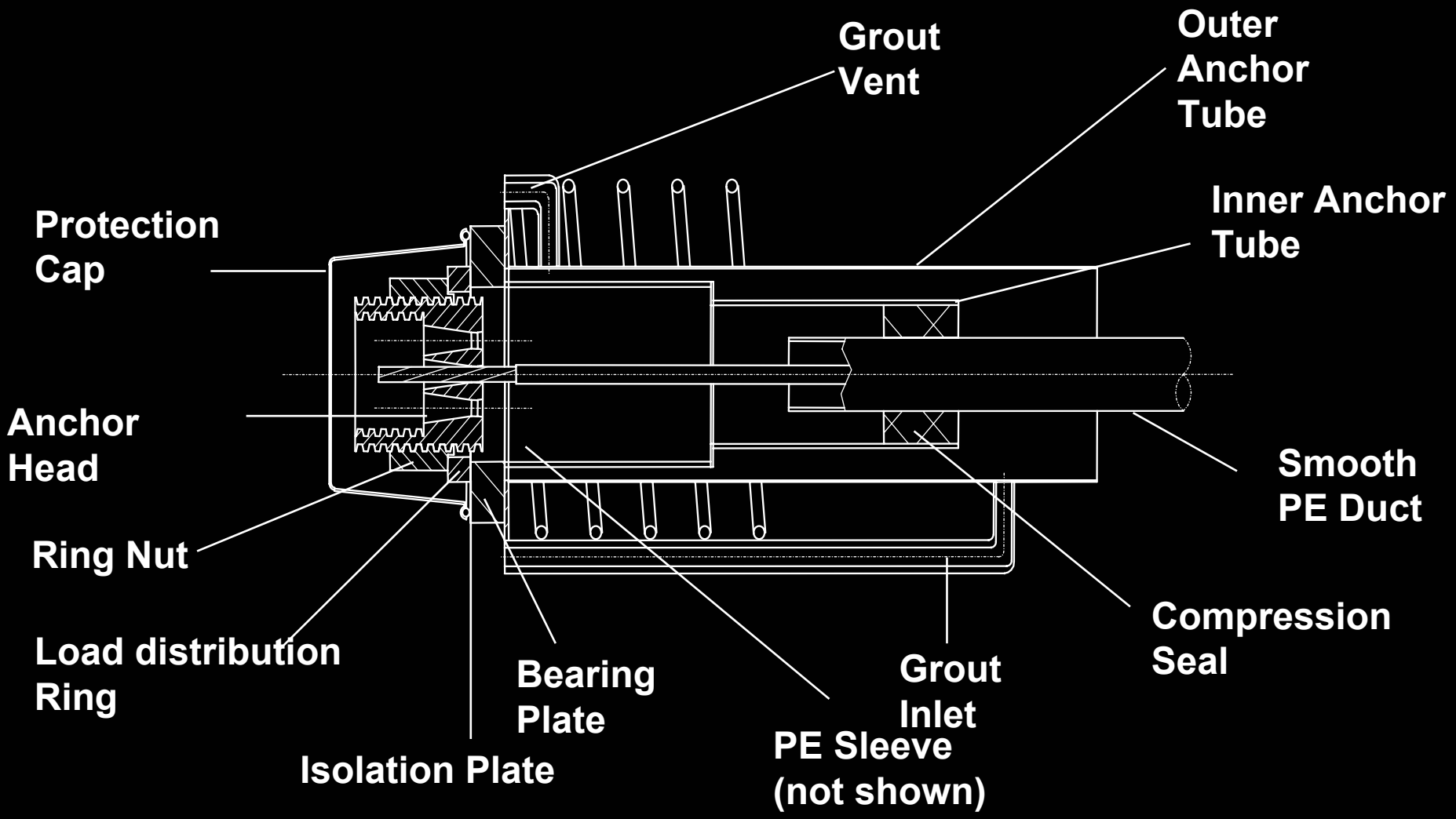
Permanent Anchorage

Adjustable - ER



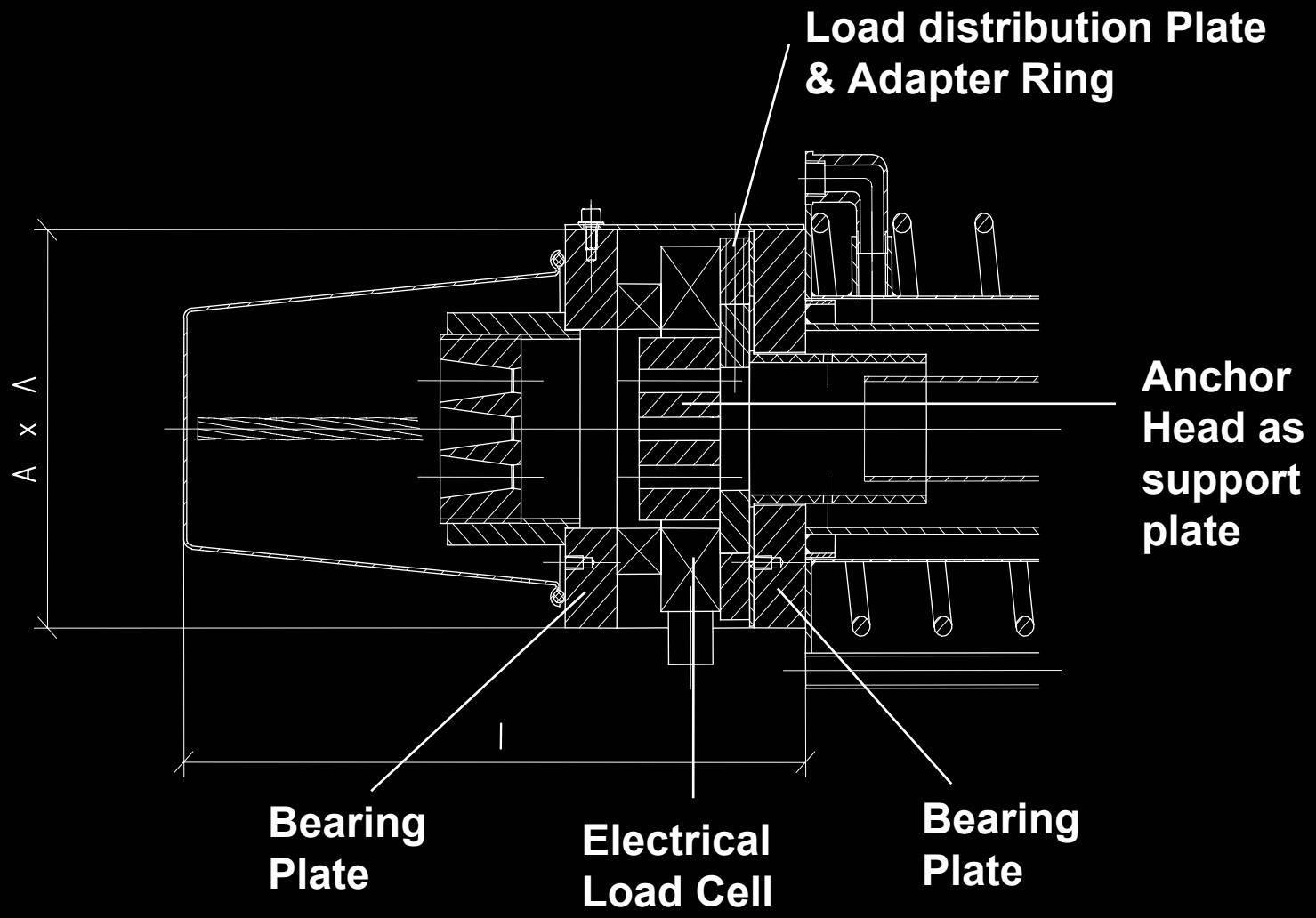
Permanent Anchorage

Destressable/Adjustable - EA



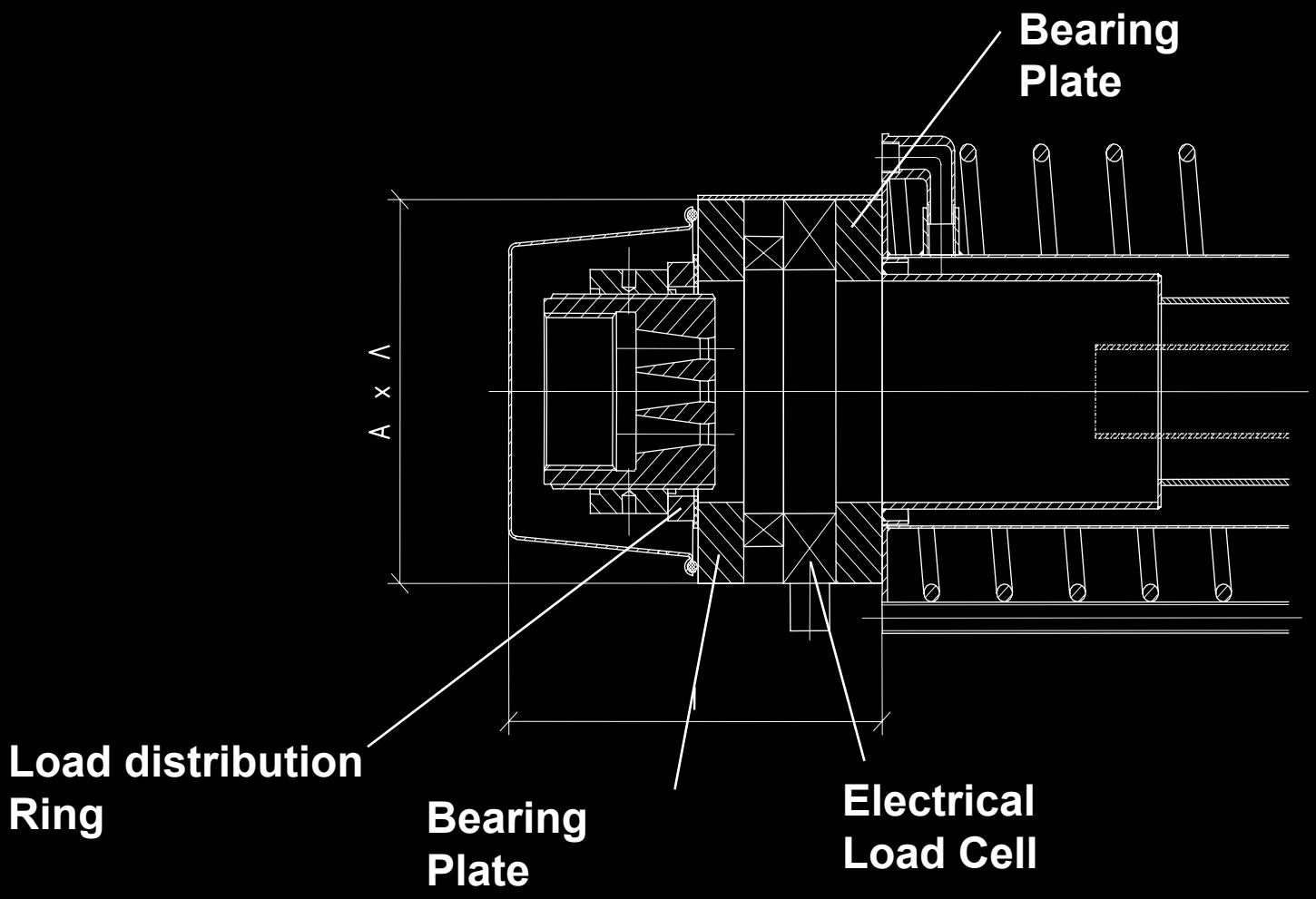
Permanent Anchorage

Surveillance - ER-D



Permanent Anchorage

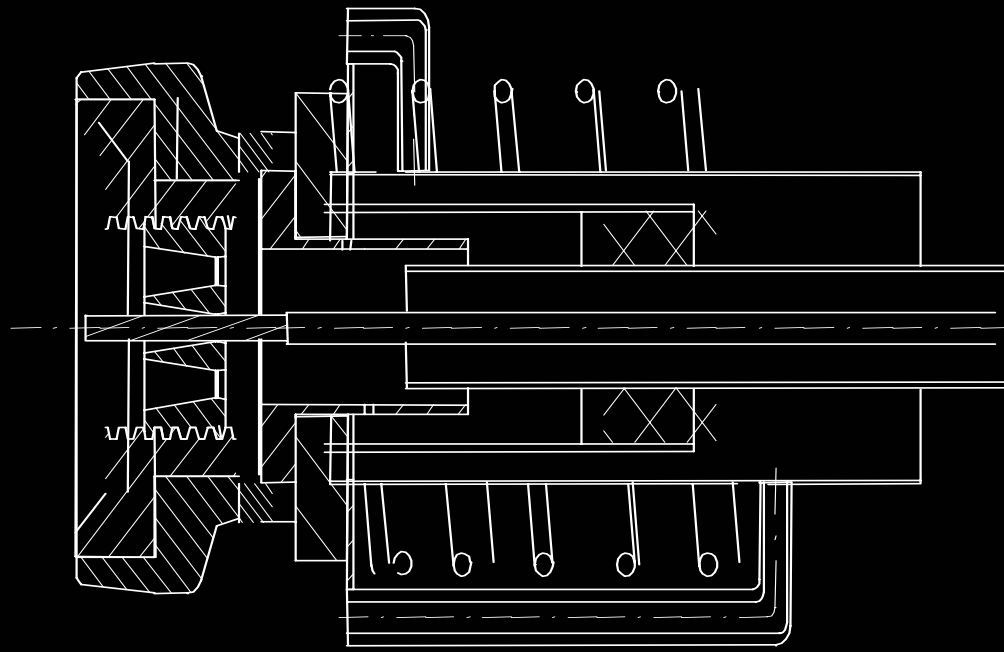
Surveillance/Detensionable - EA-D



Load Control

- Jumping Load Cell
- APP (Anchor Load control Jack)
- Hydraulic Stressing Jack (with stressing chair)
- Electrical Load Cell

Jumping Load Cell / EG Anchorage



Jumping Load Cell / EG Anchorage

Anchor Load Control Jack

Hydraulic Center Hole Jack

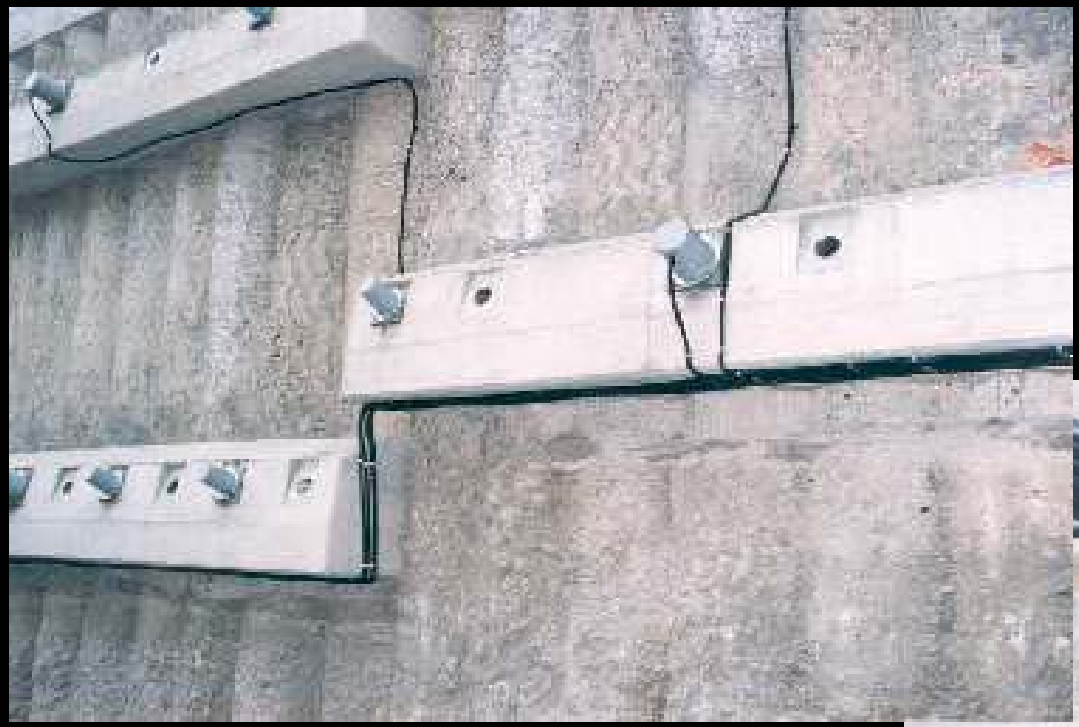
Anchor Head Gripper device

Load control with Stressing Jack

Load control with Stressing Jack and electrical Load Cell

Load control with electrical Load Cells on temporary anchors

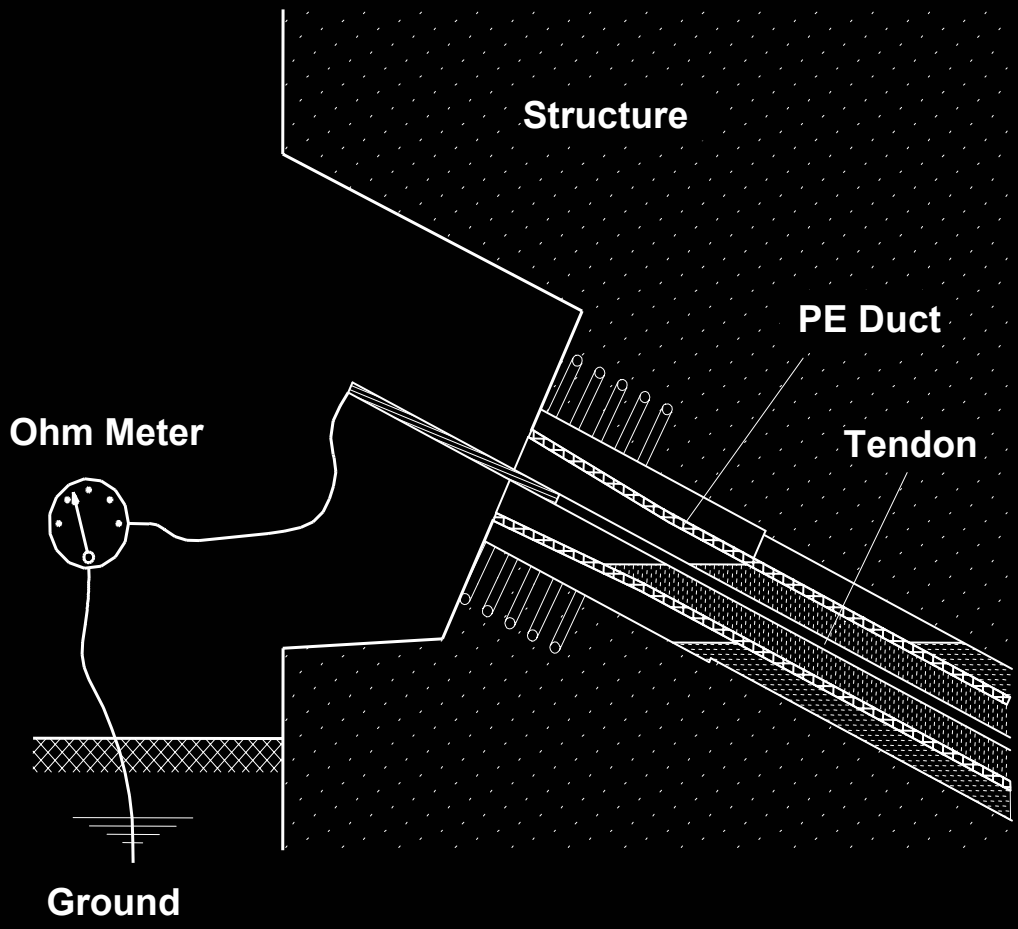
Permanent Monitoring



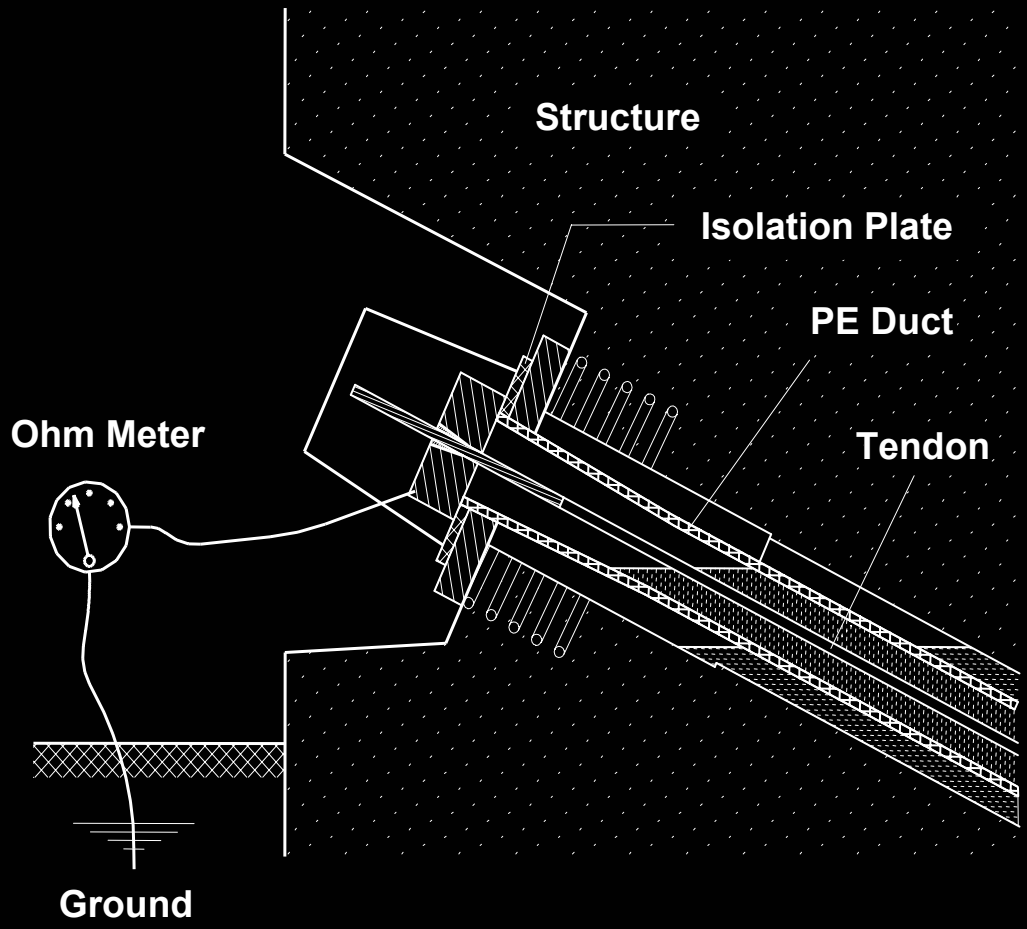
Field Inspection

- State of Anchorage
- Grease renewal
- Seal replacement

ERM – Unstressed Anchor



ERM – Stressed Anchor



ERM On Site

Grouting

Grouting Objectives

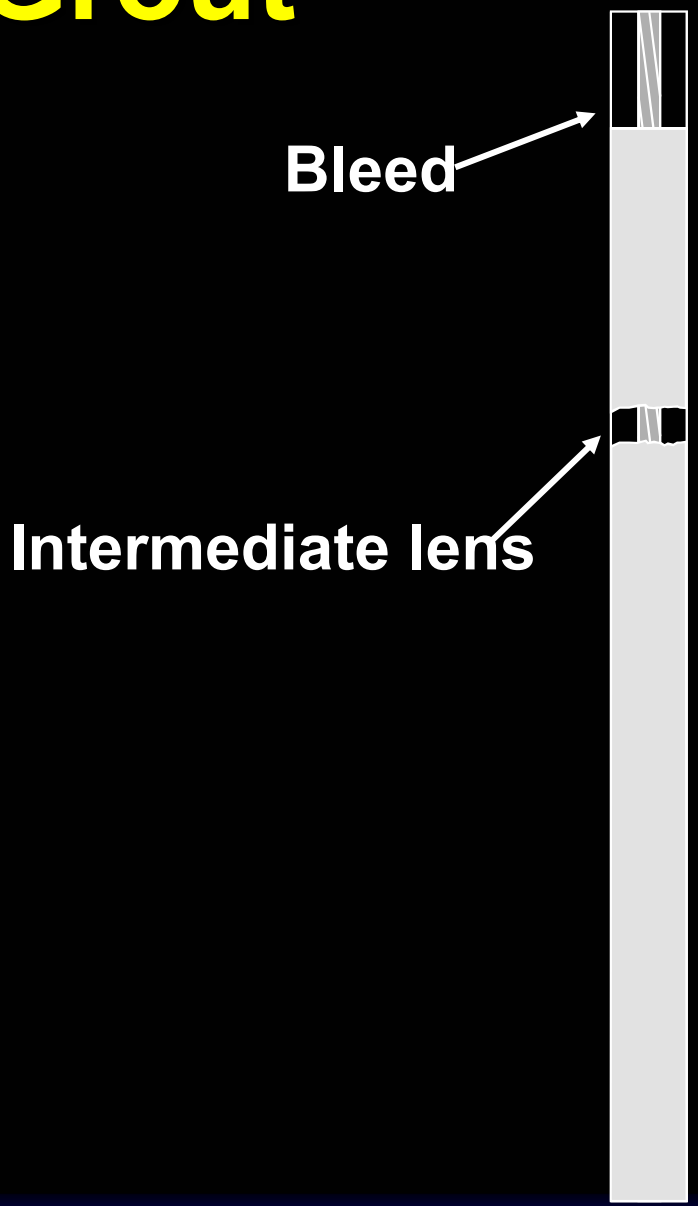
- **Enhance Durability**
  - Fill the Tendon
  - Passivate the Steel
- **Develop Bond**
  - Adequate Strength

Grouting

- Mix Design
- Procedures
- Equipment
- Personnel
- Quality Control

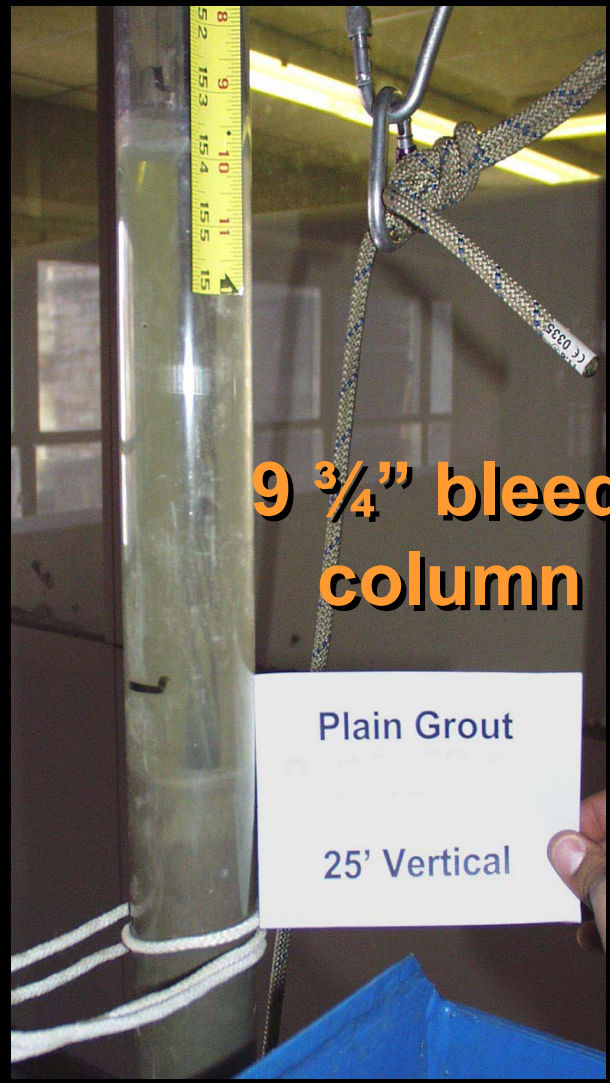
Bleed in Grout

- Bleed water is trapped in duct- causes voids
- Higher vertical rises = higher pressures and more bleed water
- Strand promotes bleed by wicking



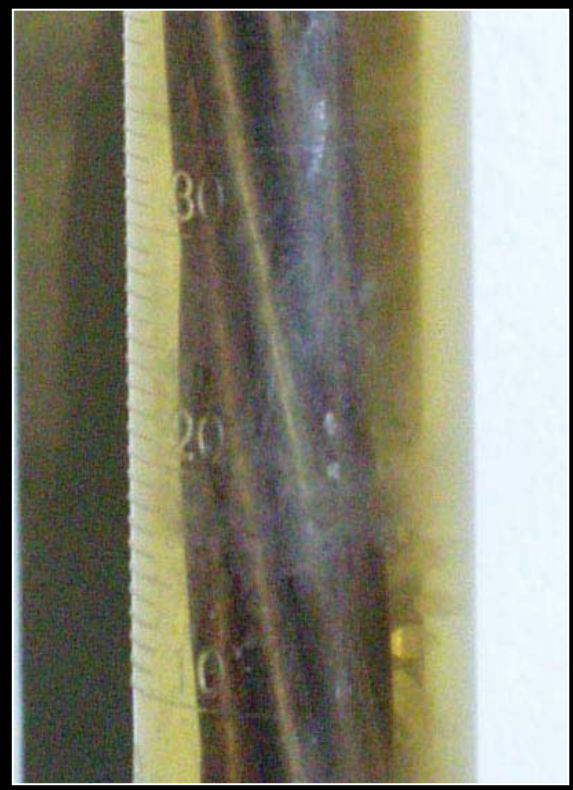
Bleed Lenses

- Voids
- Loss of protective environment



Bleed Water

Bleed water from plain grout



Admixture in bleed water

PTI Bleed Tests

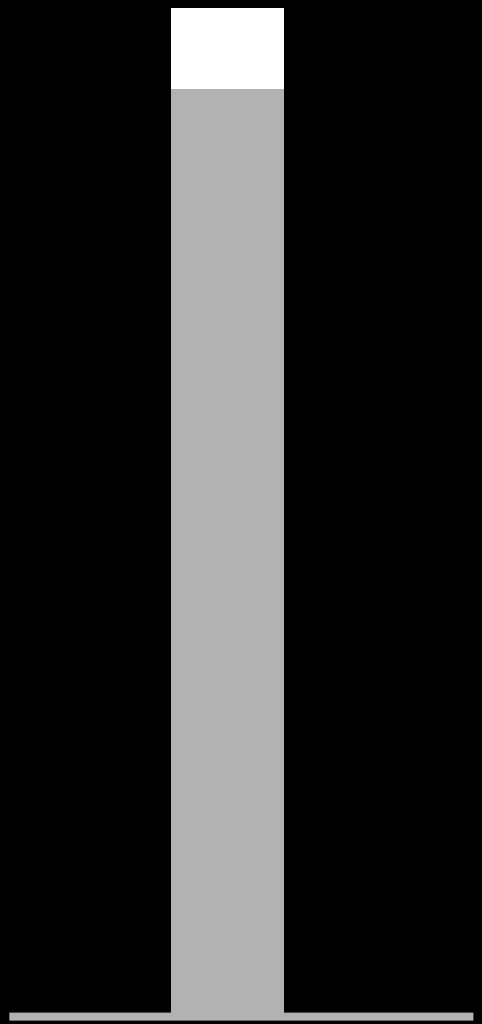
- **Wick Induced Bleed Test**
  - ASTM C940
  - Limit to 0.0% at 3 hours
- **Schupack Pressure Bleed Test**
  - Required for Class B and D grouts

Inclined Tube Test

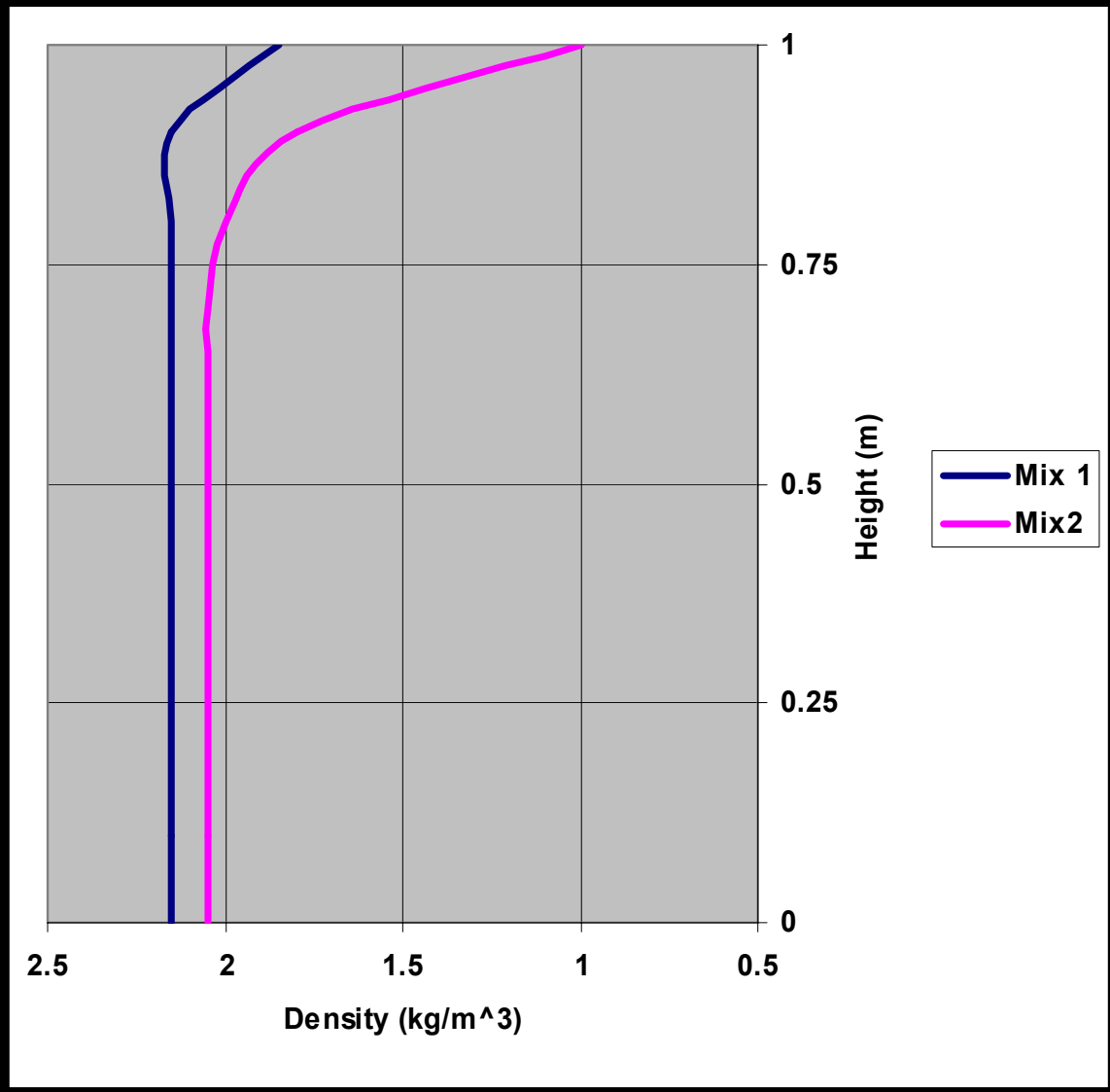
Trial Mixes

- Cement Selection
- Compatibility with Admixtures
- Minimize Bleed
- W/C Ratio
- Stability

Homogenous Grout



Grout Column



Equipment - Grout Plants

- Homogenous Grout
- High Speed Mixer >1500 rpm
- Water Measuring System

Grout Mix + Mixer = High Quality Grout

- Trial Batches
  - Production Batch Size
  - Temperature Range
  - Identical Ingredients
  - Batching Sequence

Trial Batches

- **Workability**
  - Flow
  - Stability
- **Measure Performance**
  - Bleed
  - Density
  - Strength
- **Mixing Time**
  - Manufacturer's Recommendations
  - ≅ 4-5 Minutes
  - Mixer Optimization Process

Personnel

- Experience
- Training
- Commitment

Thank You